

Hard Probes in High-energy Heavy Ion collisions *

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There are many proposed signals of a quark-gluon plasma. Among them, hard probes associated with hard processes are especially useful because they are produced in the earliest stage of the interaction and their abilities to probe the dense matter are less complicated by the hadronization physics. In this talk, I will only concentrate on high- p_T particle suppression due to jet quenching. Medium-induced radiative energy loss of a high-energy parton traversing a dense QCD medium is interesting not only because it illustrates the importance of quantum interference effects in QCD, but also because it depends sensitively on the density of the medium and thus can be used as a probe of the dense matter formed in ultrarelativistic heavy-ion collisions. One can measure parton energy loss indirectly via the modification of the jet fragmentation function and jet profile. Here, the effects of energy loss on single-particle distributions both in the normal central $A + A$ collisions and in events with a tagged direct photon with known transverse energy are reviewed.

The p_T distribution of particles from jet fragmentation in a normal central heavy-ion collision can be calculated via the convolution of the fragmentation functions with the jet cross sections. In AA collisions, one has to take into account the modification of the jet fragmentation functions due to parton energy loss inside the medium. Then, jet energy loss will result in the suppression of high p_T particles as compared to pp collisions. Therefore, the ratio of particle spectra in AA and pp at large p_T in Fig. 1 is smaller than one due to the energy loss suffered by the jet partons. It, however, increases with p_T because of the constant energy loss. The ratio is normalized to the effective total number of binary pp collisions in a central AA collision.

In order to study the modification of the fragmentation function due to energy loss, one might in principle measure the inclusive p_T spectrum in the direction of a triggered jet. However, with the large background and its fluctuation due to hadrons from many other minijets and soft processes, the determination of the jet energy is al-

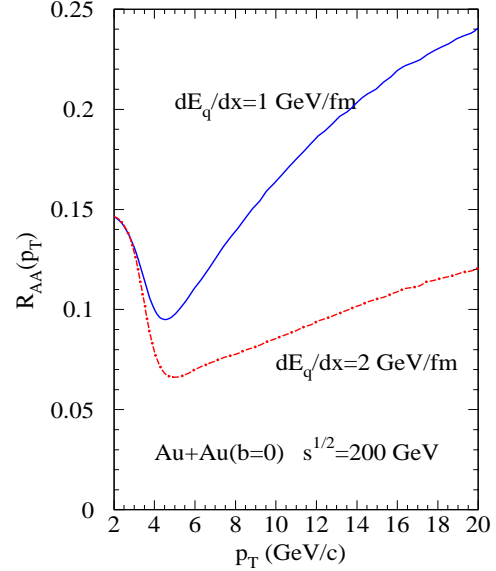


Figure 1: The ratio of charged particle p_T spectrum in central $Au + Au$ collisions at $\sqrt{s} = 200$ GeV over that of pp collisions, normalized by the total binary nucleon-nucleon collisions in central $Au + Au$ collisions. The mean-free-path of a quark inside the medium is assumed to be 1 fm.

most impossible. To overcome this difficulty, we proposed the study of the high p_T particle spectrum in the opposite direction of a tagged direct photon. Direct photons are always accompanied by a jet in the opposite transverse direction. The average energy of the jet is approximately that of the tagged photon. One can therefore relate the p_T distributions of hadrons in the opposite direction of a tagged photon to the fragmentation function of a jet with known initial energy and study the modification of the fragmentation function due to parton energy loss.

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